| | |
|---|---|
| Title | Relationship of speech rhythm, stuttering frequency and discourse type |
| Author(s) | Lam, Hiu-fung, Stephen; 林曉峰 |
| Citation | Lam, H. S. [林曉峰]. (2013). Relationship of speech rhythm, stuttering frequency and discourse type. (Thesis). University of Hong Kong, Pokfulam, Hong Kong SAR. |
| Issued Date | 2013 |
| URL | http://hdl.handle.net/10722/238547 |
| Rights | The author retains all proprietary rights, (such as patent rights) and the right to use in future works.; This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License. |

# Relationship of Speech Rhythm, Stuttering Frequency and Discourse Type

Lam Hiu Fung, Stephen

A dissertation submitted in partial fulfilment of the requirements for the Bachelor of Science (Speech and Hearing Sciences), The University of Hong Kong, June 30, 2013.

**Abstract**

The present study aimed to compare the speech rhythm of reading and conversation in Cantonese and investigates the relationship between stuttering frequency and speech rhythm across the two types of discourse. Eight native Cantonese-speaking adults diagnosed with stuttering participated in the study. Each participant read a non-emotion-provoking expository passage in the reading task and engaged in conversation on casual topics with the investigator in the conversation task. Speech rhythm and stuttering frequency of the collected speech samples were analyzed. Speech pattern in reading was shown to be more syllable-timed than in conversation using acoustic analysis. However, results showed no significant difference in stuttering frequency in reading and conversation. The relationship between difference in speech rhythm and stuttering frequency in reading and conversation in Cantonese was discussed with reference to the current model of causes of stuttering and the linguistic features of Cantonese. The findings provided insight on appropriate use of reading and conversation tasks in clinical assessment and treatment of stuttering.

Stuttering is characterized by the unpredictable occurrence of stuttering moments across different speaking contexts (Quesal, 2007). For instance, stuttering frequency may differ in conversation and in reading (Ludlow, 1990; Manning, 2000; Quesal, 2007). Some scholars hypothesized that stuttering moments may be more frequent during reading as people who stutter (PWS) are not able to use any strategies such as word avoidance, substitution of words and rephrasing to hide the anticipated stuttering behaviors (Manning, 2000; Quesal, 2007). However, such a hypothesis of higher stuttering frequency during reading was not supported by empirical data. Studies directly comparing stuttering frequency of PWS during reading and conversation generally found that there were less stuttering in reading aloud than in conversation (Greiner, Fitzgerald, & Cooke, 1986; Johnson, 1961). In the earliest study conducted by Johnson (1961), a comparison of the stuttering frequency was made in 50 PWS between the task of reading aloud (reading a 300-word passage) and conversation (answering questions related to vocation). Participants exhibited higher stuttering frequency in general in conversation than reading. Similar result was also reported in a study comparing fluency of PWS and normal people (Greiner et al., 1986), in which PWS exhibited higher stuttering frequency than normal participants in conversation but not in the reading task.

The reason for the lower stuttering frequency observed in reading when compared to conversation is unclear. It was generally attributed to the higher task demands involved in conversation as suggested in the Demands and Capacity Model (DCM) (Starkweather, 1987). The DCM proposed that the language formulation process might affect speech motor control in PWS. An imbalance between the capacity and task demands including linguistic, motoric, cognitive or social demands during the production of self-formulated speech would lead to more frequent stuttering (Peters & Starkweather, 1990; Starkweather, 1987). An equivalent phenomenon of this imbalance can be observed when PWS were requested to carry out a task of hand tapping and speech tasks simultaneously. PWS had more difficulty coordinating

both tasks and demonstrated higher stuttering frequency than normal participants only during conversation but not in reading task (Greiner et al., 1986). It is suggested that language formulation during conversation competed with motor programming for processing resources (Greiner et al., 1986). The DCM appears to provide a general explanation for the occurrence of stuttering. However, it did not explain the specific nature of the disruption and the underlying process that leads to the stuttering behaviors observed (Packman, 2004). For example, it is not clear why stuttering manifests with the symptoms of repeated movement and fixed posture when the disruption occurs.

Based on the logic that high motoric demand may trigger stuttering (Greiner et al., 1986), the Variability model (Vmodel) proposed by Packman, Onslow, Richard, and Doorn (1996) may provide a more satisfactory explanation for the difference in stuttering frequency in reading and spontaneous speech when compared to the DCM. The Vmodel suggests that stuttering is frequently triggered in people who have an unstable speech motor control when performing tasks with higher motoric demands, where higher motoric demand may be due to the varying linguistic stress during speech (Packman et al., 1996). The variability of linguistic stress during speech is considered to tax more motoric resources. In other words, when one is speaking with varying stress and intonation, a large amount of variability would be introduced into the task. This speech task can be considered as requiring higher motoric coordination than asking someone to speak in a monotone manner and hence may trigger more stuttering. On the contrary, when one is speaking in a syllable-timed pattern, that is, relatively consistent vowel length, variability in vowel duration is much reduced. The reduced variability in vowel duration in turn reduces the motoric demands and stuttering can be inhibited (Packman, Onslow, & Menzies, 2000). The Vmodel was supported by one of the widely used treatment approaches of stuttering called ‘Syllable-timed speech’, which has been proved to be effective in adults, school-age children and even preschoolers (Andrews et

al., 2012; Packman et al., 2000; Trajkovski et al., 2009).

According to the Vmodel, the lower stuttering frequency noted in reading when compared to spontaneous speech may be associated with a relatively more syllable-timed speech pattern (i.e. producing each syllable in a more discrete and rhythmic way) during reading. However, the relationship between the difference in speech rhythm and the difference in stuttering frequency between reading and spontaneous speech has not been directly examined. The present study therefore aimed to compare the speech rhythm in Cantonese-speaking adults who stutter in the contexts of reading and conversation using acoustic analysis. The findings can further improve our understanding of the Vmodel.

**Speech Rhythm in Chinese**

In the English literature, there is a dearth of studies comparing the speech rhythm in reading and conversation even in normal population. Given the syllable-timed nature, Chinese has received more research attention on its speech rhythm. For example, it has been shown that reading in Mandarin Chinese is more syllable-timed than self-formulated speech in normal speakers using acoustic analysis (Lin & Wang, 2007). The syllable timing of Cantonese Chinese is also found to be similar to Mandarin. Both languages are known as syllable-timed languages in which the duration of each syllable is almost the same when compared to stress-timed languages such as English, in which the length of each syllable is more varied but the time between consecutive stressed syllables is of equal duration (Bauer, 1997; Mok & Dellwo, 2008). Based on these findings, it is hypothesized that reading would be more syllable-timed than conversation in Cantonese.

**Present Study**

The primary aim of the study was to compare the speech rhythm of reading and conversation. The speech rhythm of the samples of PWS during reading and conversation was compared using acoustic analysis and the results could testify whether reading is more

syllable-timed than conversation in Cantonese. If reading is more syllable-timed than conversation in Cantonese, it may be expected that the stuttering frequency may be significantly lower during reading. To test this hypothesis, the second aim of the study was to investigate the effect of speech rhythm on stuttering frequency across the two types of discourse.

Investigation on the difference in stuttering frequency between reading and conversation and the relationship between the stuttering frequency and speech rhythm across the two types of discourse types is of great theoretical and clinical importance. The results of this study can help substantiate the findings of previous study on the difference in stuttering rate in reading and conversation as well as to contribute to the understanding of the manifestation of stuttering in different the discourse types. It may also provide insight to clinicians on how oral reading and conversation tasks could be utilized in the clinical assessment and treatment of stuttering.

## Method

### Participants

Participants were recruited via mass emails at the University of Hong Kong and the Chinese University of Hong Kong. The recruitment inclusion criteria included, (1) having self-perceived stuttering or being diagnosed with stuttering previously; (2) being a native Cantonese speaker; (3) age of 18 or above; (4) no history of neurological disorders and (5) no history of speech and language disorders other than stuttering. A total of nine adults replied to the emails and reported that they had “dysfluent” speech. All participants were screened by a qualified speech therapist and the investigator. One of the nine adults did not demonstrate any stuttering behaviors but articulation errors, hence was not recruited to the study. As for the other eight participants, the diagnosis of stuttering was confirmed by a Cantonese-speaking speech therapist specialized in stuttering. The final sample therefore

consists of six males and two females with stuttering. The participants were in the age range of 18 to 33 years old (mean age = 25.3 years). All participants completed an adult stuttering questionnaire (see Appendix A) which confirmed the absence of any neurological disorders and speech and language disorders other than stuttering in their medical history.

**Procedures**

Each participant was required to perform two speech tasks, oral reading and conversation. The two tasks were presented to the participants in a randomized order.

**Reading.** A non-emotion-provoking expository passage, "文房四寶 /mɐn4 fɔŋ4 sei3 pou2/" (*Four Treasures of the Study*), was used as the reading material (see Appendix B). The reading passage consisted of 921 syllables and was extracted from a junior high-school level Chinese textbook published in Hong Kong. Each participant was required to read the passage aloud in their habitual loudness, pitch and reading style.

**Conversation.** Each participant engaged in conversation with the investigator on a variety of familiar and casual topics (e.g., hobbies and favourite food) using a set of standard questions. The questions were presented to the participants in a randomized order. The conversation was estimated to elicit similar length of speech as the passage in the reading task. Before the task began, the participants were reminded to use their habitual loudness, pitch and speaking style throughout the conversation. All reading and conversation samples were audio- and video-recorded in a quiet room to ensure the quality of the sample for later data analysis.

**Measures**

**Measurement of speech rhythm.** The traditional acoustic correlates for measuring speech rhythm included ΔV (standard deviation of vocalic duration), ΔC (standard deviation of consonantal duration) and %V (proportion of vocalic intervals within an utterance) (Ramus, Nespor, & Mehler, 1999). In a subsequent study, Dellwo and Wagner (2003) reported that

ΔV and ΔC were inversely related to speech rate. Their equivalent rate-normalized measures, namely VarcoV (coefficient of variation of vocalic durations) and VarcoC (coefficient of variation of consonantal duration), were suggested by Dellwo (2006) to better represent speech rhythm. Based on these studies, the acoustic measures for speech rhythm used in the present study were VarcoV, VarcoC and %V. The formulae for the three measures are as follows:

VarcoV = (ΔV/ mean vocalic duration in the utterance) × 100

VarcoC = (ΔC/ mean consonatal duration in the utterance) × 100

%V = (vocalic duration/total duration of the utterance) × 100

*Low* values of VarcoV and VarcoC value represent smaller variation in the vocalic and consonantal duration respectively, suggesting that the rhythm of the speech sample being analyzed is more *syllable*-timed (Dellwo, 2006; White & Mattys, 2007). On the other hand, a more stress-timed speech samples or language would have a low %V as they have more reduced vowels in unstressed syllables, resulting in a lower proportion of vocalic duration within each utterance (Ramus et al., 1999). In other words, *higher* %V represents the more *syllable*-timed speaking pattern.

**Measurement of stuttering occurrence.** Stuttering is manifested as a breakdown of speech fluency at syllable level (Packman, Code, & Onslow, 2007), therefore the outcome measure used was based on syllables stuttered. The measure of percentage of syllables stuttered (%SS), was used in the present study as it has been reported to have high interjudge argeement (Ingham et al., 2001; Lincoln & Onslow, 1997; O'Brian, Onslow, Cream, & Packman, 2003). Operationally, %SS is calculated as the number of syllables stuttered divided by the total number of syllables in the analyzed speech sample and then multiplied by 100.

**Analysis**

**Acoustic analysis of speech rhythm.** The first ten utterances of the selected speech sample that contains 600 syllables were used for analysis of speech rhythm. All the acoustic analyses were conducted by using the acoustic-analysis software *Praat* (Boersma & Weenink, 2011). Each utterance was then segmented and labeled into consonantal intervals and vocalic intervals manually by the author. Any silent gaps within utterance, which were not occupied by consonants or vowels, were not coded for further analysis. The boundaries among consonantal and vocalic intervals were identified by listening to the speech sample and observing the spectrogram based on the criteria in Grabe and Low (2002). Specifically, onset of vocalic interval is marked by an obvious increase in amplitude and emergence of a relatively stable formant pattern whereas onset of consonantal interval is indicated by the distinctive acoustic cues with respect to the manner of articulation of the consonants. The intervals stretched by glides were labeled using the guidelines suggested by Grabe and Low (2002). Postvocalic glides were labeled as vowels since the intervals stretched by the glides were acoustically indistinguishable from that of the preceding vowel whereas prevocalic glides were generally considered as consonants unless no acoustic cue of change in amplitude and formant pattern could be observed in the spectrograms. The intervals stretched by stuttering events in the samples were also included in the acoustic and analysis and they were labeled depending on their nature of the stuttering behaviors. The silent pauses associated with fixed posture without airflow were treated as silent gap within utterance and were not coded as consonantal or vocalic intervals. For fixed posture with airflow and repeated movements, the prolongations and repetitions produced were just labeled using the same criteria that applied to the segmentation of nonstuttered syllables.

After segmentation, a Praat script written by Yoon (2008) was run to extract the consonantal and vocalic intervals and calculate the values of VarcoV, VarcoC, and %V for each utterance. The values for the ten utterances in each discourse type were then averaged

for each participant to obtain a mean value of the three measures for each speech sample produced by the participants.

**Stuttering identification.** Stuttering identification was conducted by the author and was cross-checked by two qualified speech therapists experienced in stuttering management. The first 300 syllables obtained in both reading and conversation were excluded from the analysis and the following consecutive six hundred syllables were used. Each rater viewed the video samples independently and used a button-press counting device to count the number of syllables stuttered (O'Brian, Packman, Onslow, & O'Brian, 2004). Stuttering moments were identified based on the taxonomy of the Lidcombe Behavioral Data Language as it provides a way of describing stuttering behaviors with high levels of agreement among experienced raters (Teesson, Packman, & Onslow, 2003). With the use of the taxonomy, stuttering behaviors include (1) repeated movements including syllable repetition, incomplete syllable repetition and multisyllable unit repetition (equivalent to repetition); (2) fixed posture with airflow (equivalent to prolongation) or fixed posture without airflow (equivalent to block); and (3) superfluous verbal/nonverbal behaviors (Teesson et al., 2003). After counting the number of syllables stuttered, the percentage of syllables stuttered (%SS) in each sample was calculated.

**Intra-rater Reliability and Inter-rater Reliability of Stuttering Frequency**

The author and two speech therapists experienced in stuttering rated the stuttering frequency in the samples and intraclass correlation coefficient (ICC) was calculated among the author's rating and the two speech therapists' ratings of %SS on all the samples. ICC (2,1), which represents two-way random single measure, was chosen to calculate the inter-rater reliability as the raters in the present study were considered to be selected randomly from a population of people who are able to carry out stuttering identification. A single measure from the author, rather than an average of the three raters was used in the

present study. The ICC values were .937 ($p < .001$) for stuttering ratings of reading samples and .971 ($p < .001$) for stuttering ratings of conversation samples, indicating a significantly high degree of inter-rater reliability among the three raters. For intra-rater reliability, the author repeated the process of stuttering identification for all samples. The correlation between the author's first and second rating of %SS was calculated. The Kolmogorov-Smirnov test indicated that %SS of the reading samples were not normally distributed for both the first set of ratings [$D(8) = 0.333$ , $p < .05$] and second sets of rating [$D(8) = 0.338$ , $p < .05$], Kendall tau rank correlation coefficient was used. The result revealed that there was a significant and strong correlation between the first and second ratings for both reading samples ($\tau = 1.000$, $p < .05$) and conversation samples ($\tau = .929$, $p < .05$), suggesting an excellent intra-rater reliability. To summarize, the inter-rater reliability and inter-rater reliability for the stuttering frequency were very good.

## Results

The difference in the acoustic measures of speech rhythm (VarcoV, VarcoC and %V) between reading and conversation will first be described, followed by the results of the %SS in the reading and conversation samples from the participants.

### Speech Rhythm

**VarcoV.** Figure 1 shows the mean VarcoV with standard deviation against discourse type. The distribution of the differences in VarcoV between reading and conversation samples of the participants were normal as shown in the the Kolmogorov-Smirnov test [$D(8) = 0.261$, $p = .117$]. Paired sample *t*-test, with 'type of discourse' as the independent variable and 'VarcoV' as the dependent variable, was thus conducted to compare the mean VarcoV between reading and conversation. Results indicated that the mean VarcoV of reading ($M = 51.96$, $SD = 6.15$) was significantly lower than that of conversation ($M = 67.69$, $SD = 11.31$) [$t(7) = -3.811$, $p < .01$]. It implies that reading displayed a smaller variation in vocalic

duration and would sound more syllable-timed than conversation.

Figure 2 is a graphical representation of the individual variation in average value and standard deviations of VarcoV across utterances in reading and conversation among all the participants. All participants appeared to have a lower VarcoV value in reading when compared to conversation except Participant 006.

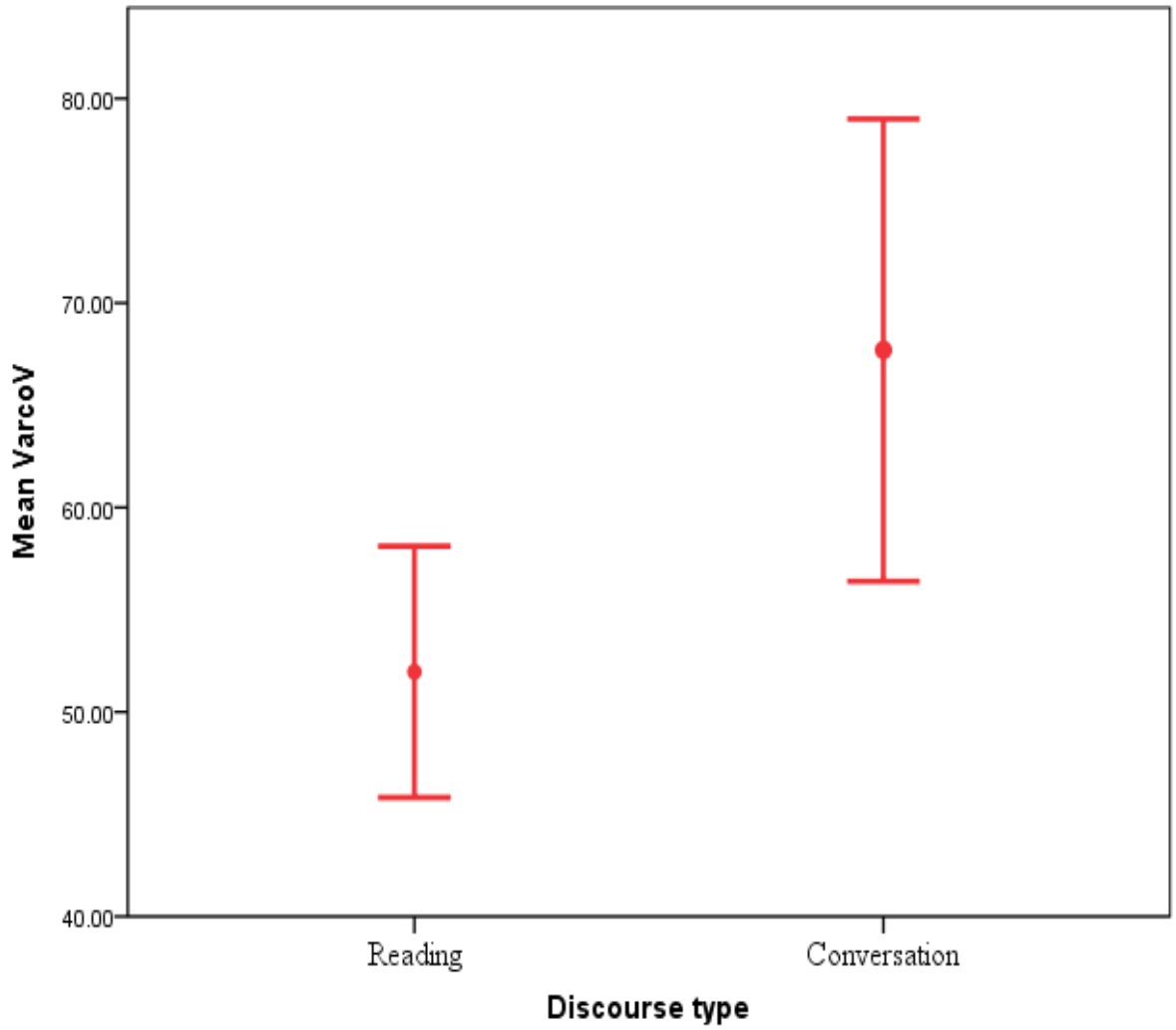


*Figure 1.* Mean VarcoV with standard deviations of reading and conversation

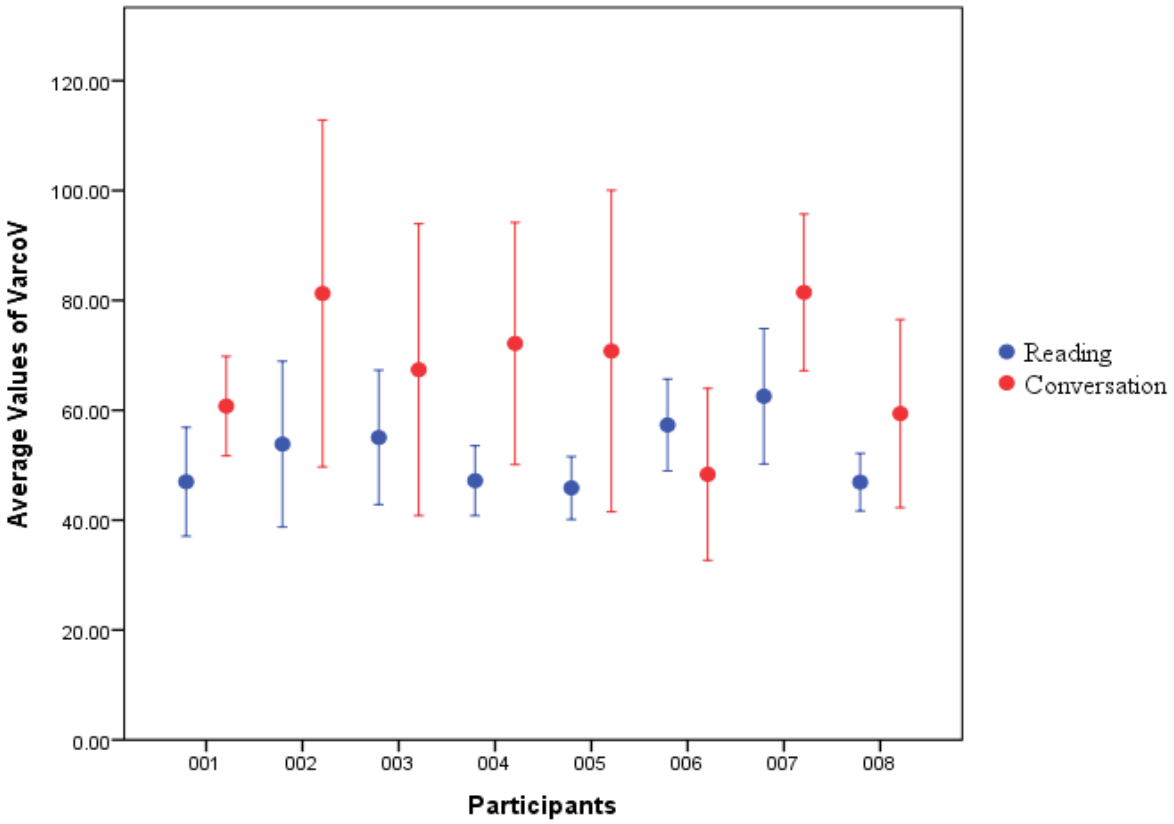


*Figure 2.* Average values and standard deviations of VarcoV of each participant across utterances in reading and conversation

**VarcoC.** Figure 3 compares the mean VarcoC between reading and conversation. A normal distribution of the differences in VarcoC between reading and conversation samples of the participants was found in Kolmogorov-Smirnov test [$D(8) = 0.179$ , $p = .200$]. Paired sample *t*-test was carried out. Results showed that the mean VarcoC of reading ($M = 59.40$, $SD = 10.00$) was significantly lower than that of conversation ($M = 68.96$, $SD = 8.90$) [$t(7) = -2.401$, $p < .05$]. It indicates that reading displayed a smaller variation in consonantal duration than conversation and would be more syllable-timed than conversation.

Figure 4 shows the average value of and the standard deviations of VarcoC across utterances in reading and conversation for each participant. Similar to the trend of individual variation in VarcoV, all participants appeared to have a lower VarcoC value in reading when compared to conversation except Participant 006.

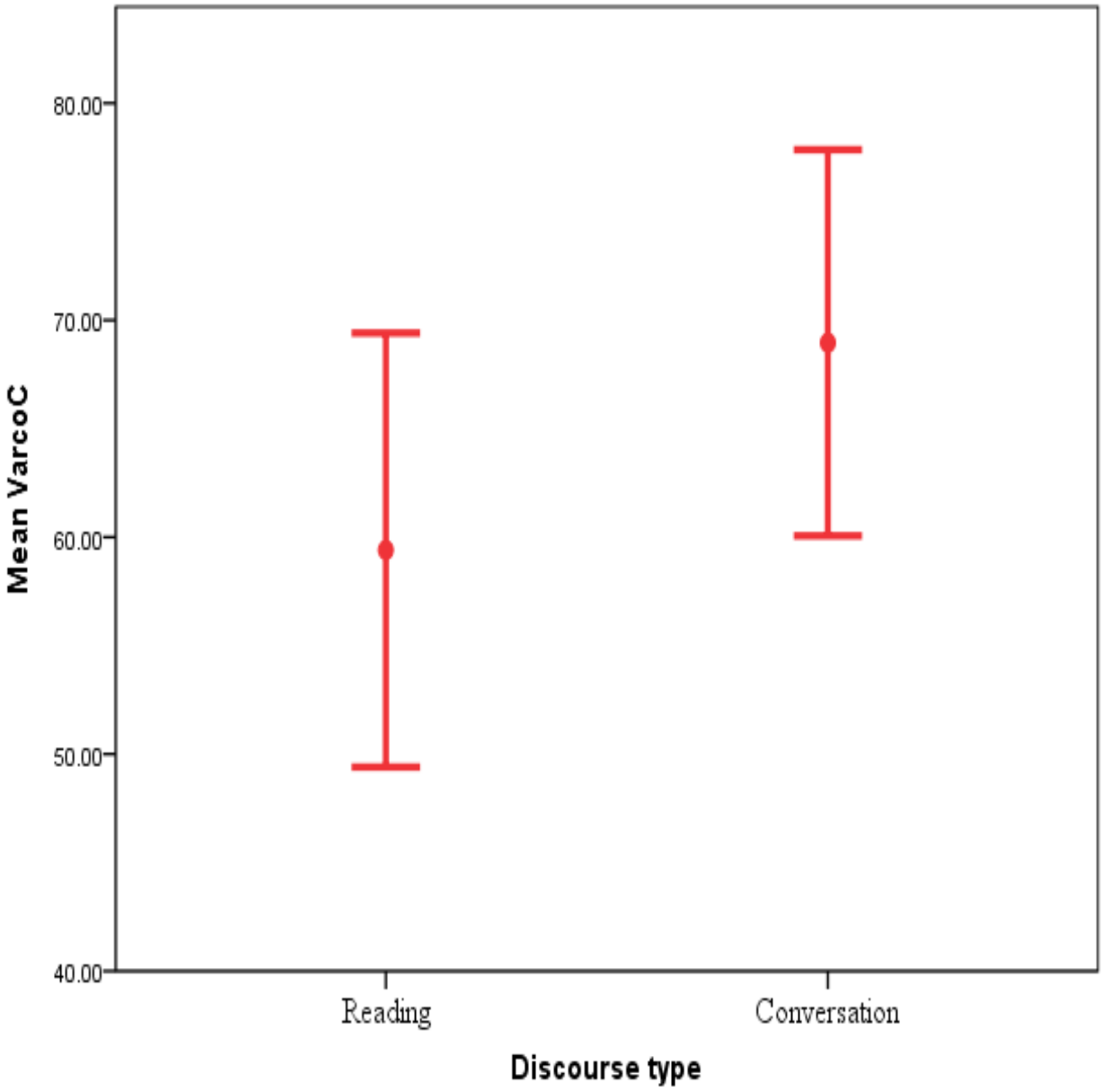


*Figure 3.* Mean VarcoC with standard deviations of reading and conversation

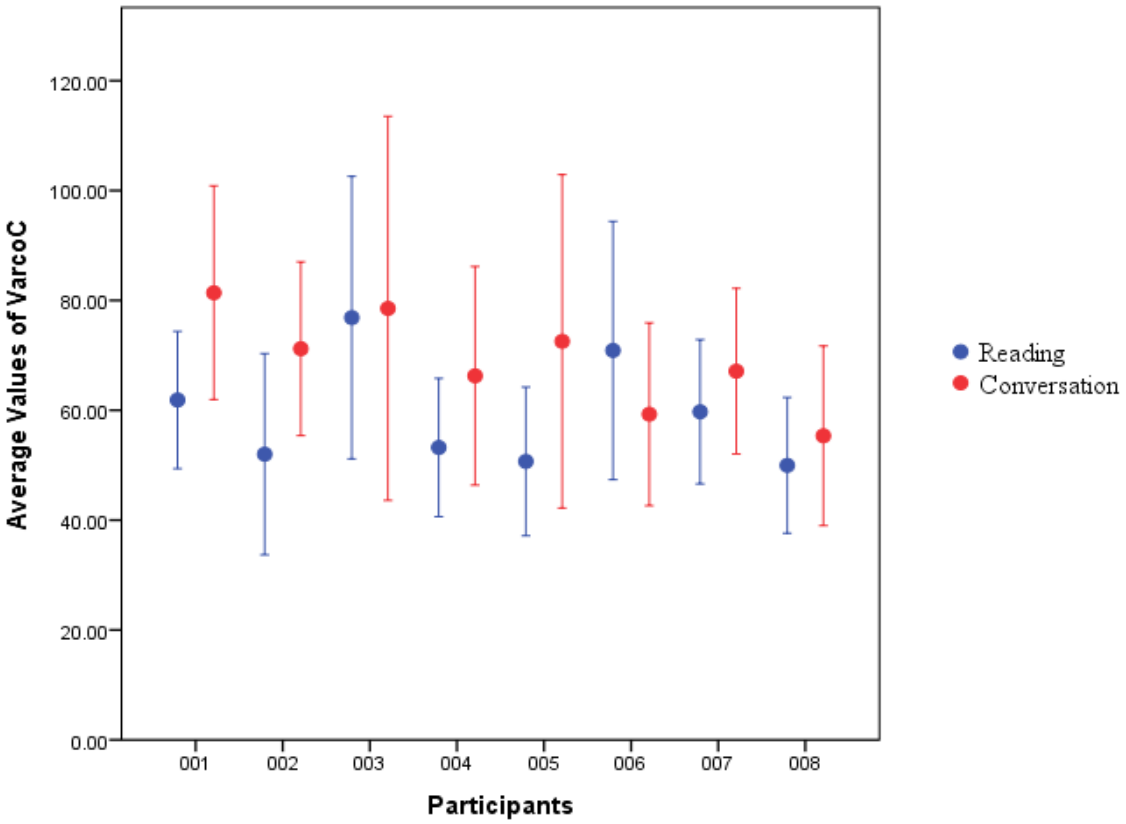


*Figure 4.* Average values and standard deviations of VarcoC of each participant across utterances in reading and conversation

**%V.** Figure 5 compares the mean %V and standard deviations of reading and conversation. The differences in %V between reading and conversation samples of the participants were normally distributed as shown in Kolmogorov-Smirnov test [$D(8) = 0.235$, $p = .200$]. Paired sample *t*-test was carried out and the results showed that the mean %V of reading ($M = 51.60$, $SD = 3.58$) was significantly lower than that of conversation ($M = 63.66$, $SD = 3.90$) [$t(7) = -6.451$, $p < 0.001$]. Unlike the two measures above, it might indicate reading is less syllable-timed than conversation.

Figure 6 summarizes the data of the average value and standard deviation of %V across utterances in reading and conversation for each participant. The average value of %V appeared to be lower in reading when compared to conversation for all participants.

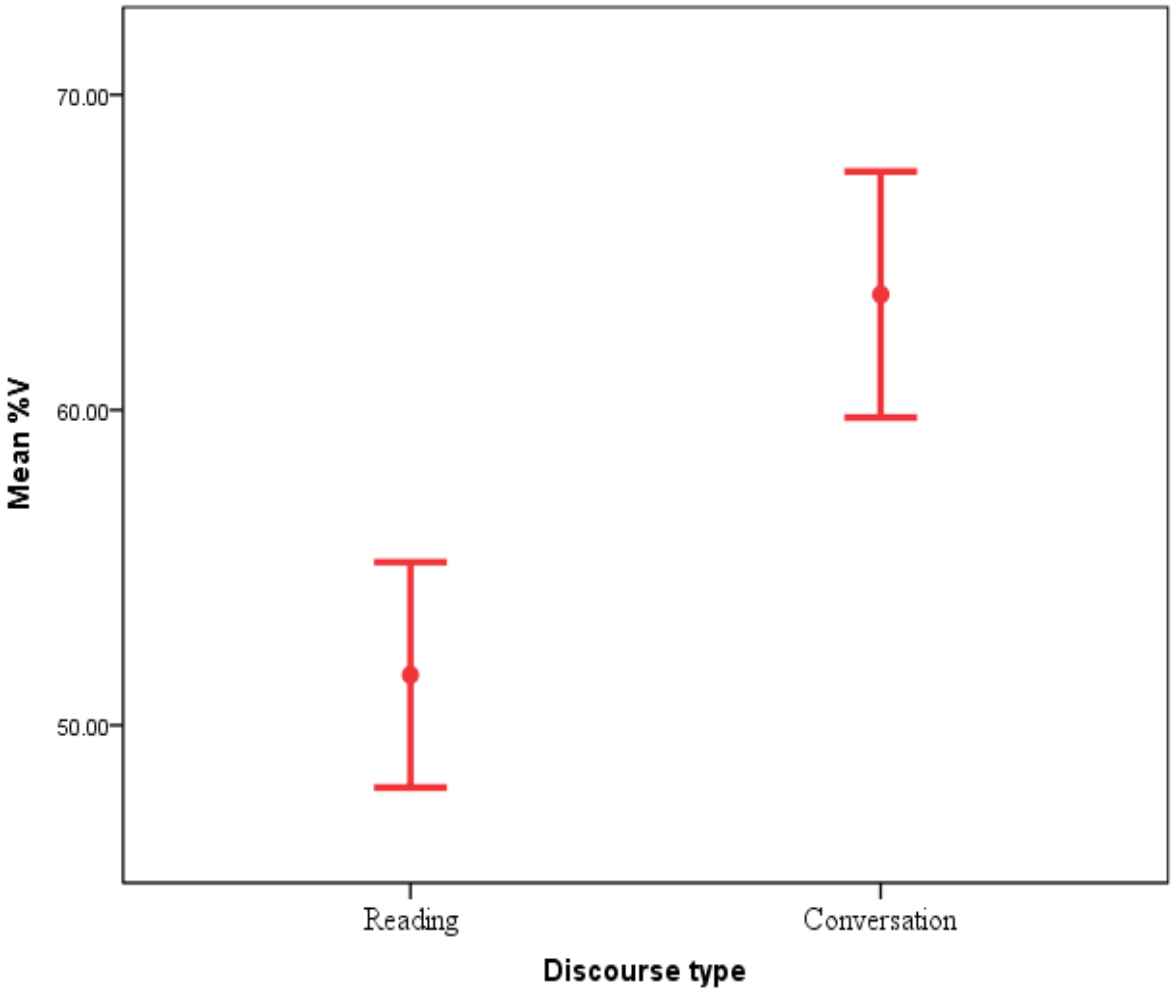


*Figure 5.* Mean %V with standard deviations of reading and conversation

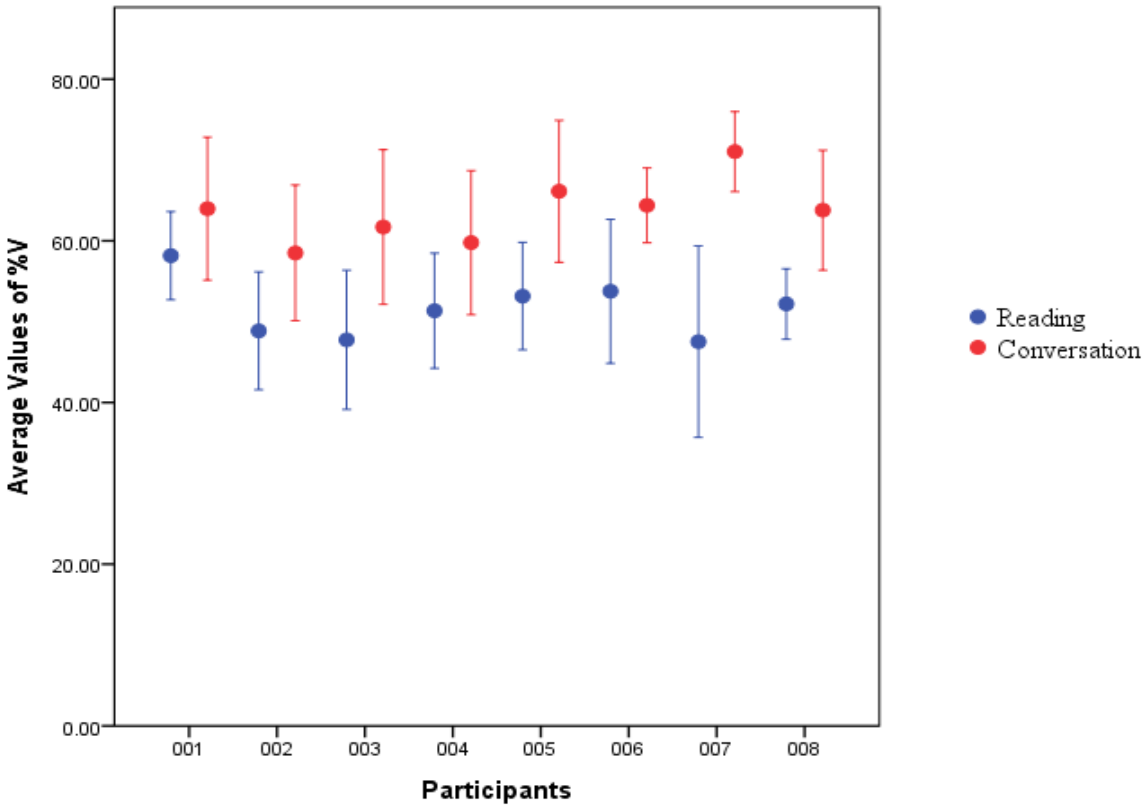


*Figure 6.* Average values and standard deviations of %V of each participant across utterances in reading and conversation

**Stuttering Frequency**

The %SS of each participant during the production of the two types of discourse was summarized in Table 1. It appeared that the stuttering frequency in conversation was not necessarily higher than reading and the severity varied among the participants. Kolmogorov-Smirnov test revealed that the differences in %SS between reading and conversation samples of the participants were normally distributed [$D(8) = 0.251$ , $p = .146$]. Paired sample *t*-test, with 'type of discourse' as the independent variable and 'percentage of syllables stuttered' as the dependent variable, was carried out to compare the stuttering frequency in the reading and conversation tasks. There was no significant difference between %SS during reading ($M = 4.98\%$, $SD = 7.68$) and during conversation ($M = 6.33\%$, $SD = 6.07$) [$t(7) = -0.673$ , $p = .522$].

Table 1

*Percentage of Syllables Stuttered in Reading and Conversation*

| Participant | Reading | Conversation |
|---|---|---|
| 001 | 0.00% | 13.64% |
| 002 | 3.37% | 1.78% |
| 003 | 11.24% | 7.36% |
| 004 | 1.12% | 2.93% |
| 005 | 0.80% | 3.94% |
| 006 | 21.67% | 17.30% |
| 007 | 1.28% | 3.34% |
| 008 | 0.32% | 0.32% |

## Discussion

The present study aimed to compare speech rhythm in reading and conversation and investigated whether the stuttering frequency across the two types of discourse was associated with speech rhythm. In the acoustic analysis of speech rhythm, the significantly lower values of VarcoV and VarcoC in reading than conversation indicated that a lower variability in vowel and consonantal durations during reading. This finding is consistent with a previous study which investigates speech rhythm in Mandarin (Lin & Wang, 2007), confirming that the speaking pattern during reading is generally more syllable-timed than that of conversation. Due to a greater need to convey the emotional content and the necessity of maintaining the naturalness in conversation, the prosody is varied more from time to time when compared to reading aloud (Rao & Koolagudi, 2013; Scherer, Johnstone, & Klasmeyer, 2003). For example, sadness and boredom are expressed with longer syllable duration than usual whereas happiness are expressed with relatively shorter syllable duration (Scherer et al.,

2003). This greater variation of syllable duration in conversation contributes to its more stress-timed nature.

Interestingly, the present study found that %V value was significantly higher in conversation relative to reading, which was in contrary to the expected results. The same pattern was also observed in a study of speech rhythm of Chinese (both Cantonese and Mandarin) in normal speakers, which reported that %V during story-retelling was significantly higher than reading the text of a story aloud (Mok & Dellwo, 2008). It may be possible that the higher %V value in conversation in the present study might be due to the inclusion of pause fillers in conversation in the analysis. In daily normal conversation, speakers use pause fillers to indicate that he/she only breaks for a short while to think and his/her turn of conversation is not finished. Pause fillers occur exclusively in conversation but not in reading. They appeared in the form of central vowel schwa [ə] and [ɛ] (Bauer, 1997). The presence of these pause fillers might have resulted in a great number of long vowel intervals and resulted in high proportion of vowel intervals in each utterance (%V) during conversation. However, further analysis without inclusion of pause fillers is required to support this speculation. Another possible reason for higher %V in conversation than reading may be that %V might be only valid in capturing the syllable-time difference in cross-linguistic studies such as English and Chinese but not suitable for more subtle difference within a language. Review on two studies carried out by White and his colleagues provided evidence to this hypothesis (White & Mattys, 2007; White, Wiget, Rauch, & Mattys, 2010). In a cross-linguistic study of speech rhythm , it was shown that the widely recognized stress-timed language (e.g. English) had significantly lower %V than the more syllable-timed languages (e.g. Spanish) (White & Mattys, 2007). However, a subsequent study which investigated speech rhythm across discourse types in English showed that the pattern of difference in %V between reading and conversation within a language varied

greatly among different speakers (White et al., 2010). By considering the limitation of %V, VarcoV and VarcoC may be better measures for measuring speech rhythm across discourse types within a syllable-timed language.

Although the two rhythmic measures (VarcoV and VarcoC) in the present study indicated that the speech pattern was more syllable-timed in reading when compared to conversation, the present study revealed no significant effect of the discourse type (reading or conversation) on the stuttering frequency. The finding did not accord well with the previous studies in English, which generally showed that stuttering occurred more frequently in conversation than reading (Greiner et al., 1986; Johnson, 1961). The lack of significant relationship between stuttering frequency and the difference speech rhythm in the present study across discourse types might be due to the typological features of Cantonese speech rhythm.

Imagine that speech rhythm is represented in a spectrum from syllable-timed nature to stress-timed nature as shown in Figure 7. If the speech rhythm in English reading and conversation span over the spectrum, the speech rhythm in Cantonese reading and conversation mainly fall to the syllable-timed end. The corresponding relationship of "stress-timed - stuttered speech" and "syllable-timed - fluent speech" may not directly hold in Cantonese. That is, when moving from the stress-timed end to the syllable-timed end on the spectrum, stuttering frequency may reduce remarkably as in the speech performance in English PWS during conversation and reading. However, since Cantonese conversation and Cantonese reading is already on the syllable-timed end, the stable linguistic stress is not sufficient to further reduce stuttering.

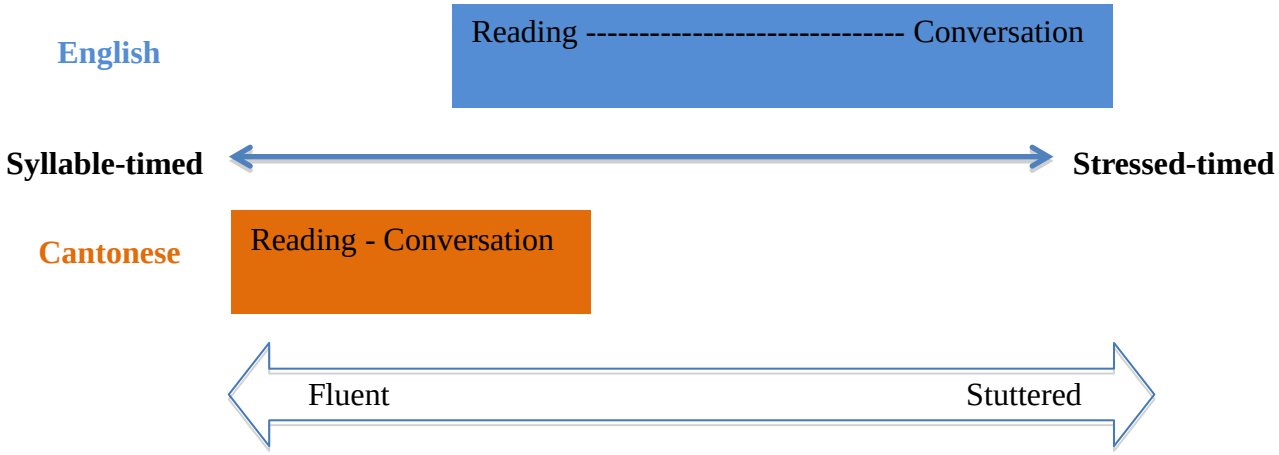


*Figure 7.* Relationship between speech rhythm in English and Cantonese reading and conversation

Other factors may therefore be more influential on the stuttering frequency in Cantonese. As mentioned in Packman (2004), the Vmodel suggested that variability of syllabic stress was only a triggering condition but not the only and essential condition for occurrence of stuttering. Therefore, any change in stuttering frequency of PWS is not necessarily associated with an increase or decrease in variability of syllabic stress. Based on this explanation, the lack of significant difference in stuttering frequency in Cantonese between reading and conversation may be attributed to some factors other than speech rhythm. It may be possible that other linguistic factors such as the grammatical class and sentence structures may have an impact on fluency (Howell, Au-Yeung, & Sackin, 1999; Wells, 1979). Adults who stutter generally exhibit more stuttering on content words than function words as they fail to provide sufficient time for planning for the production of content words (Howell et al., 1999). Stuttering may also occur more frequently in sentences which are syntactically more complex and this speculation was supported by Wells (1979), who found that PWS exhibited more stuttering in sentences with more clauses. It is possible that the effect due to difference in linguistic content of reading and conversation may have outweighed the effect of speech rhythm on stuttering frequency.

Another possible reason for lack of significant difference between stuttering frequency in reading and conversation may be due to individual heterogeneity of stuttering (Starkweather, 1999). For some PWS, reading may be a fluency-enhancing condition but it may become a fluency-disrupting condition for other PWS. Moreover, the ability to use word avoidance to hide stuttering in conversation, levels of fear and psychological stress in different speaking tasks and situations also have an impact on the speech fluency on a particular person (Guitar, 2006; Manning, 2000). These factors may play a more important role than the speech rhythm in the trigger of stuttering.

**Clinical Implications**

The present study showed no statistically significant difference in stuttering frequency between reading and conversation at least in the Cantonese PWS. The relative difference in stuttering frequency across discourse types appeared to vary from individuals to individuals. By considering this individual variability of difference in stuttering frequency across discourse types, it is therefore necessary to carry out stuttering assessment in both reading and conversation tasks in order to obtain an accurate and holistic view on speech fluency to determine the fluency-enhancing condition which is specific to each individual as well as to language the client speaks. As for treatment, the effectiveness of speech pattern modification such as syllable-timed speech and prolonged speech may vary among PWS. The present study showed that reading aloud is more difficult to certain PWS than others. There is a need to devise an individualized treatment hierarchy of difficulty for each PWS according to their performance in different speaking tasks.

**Limitations and Further Research**

The small sample size in the present study may possibly constitute a factor of failure to detect any systematic difference in stuttering frequency between reading and conversation. A larger number of participants may provide more conclusive results. In addition, future

study may include participants with a variety of stuttering behaviors to assess whether there is a relationship between discourse type and the participant's dominant stuttering behaviors (i.e. repetition, prolongation or blocks). Finally, as mentioned before, it would be useful to evaluate whether %V is a satisfactory measure of speech rhythm across discourse type within a syllable-timed language by excluding the pause fillers from the samples. If value of %V in conversation is still greater than reading without inclusion of pause fillers, it is likely that %V may not be valid for capturing more subtle difference in speech rhythm among speech samples within a language.

## Conclusion

The present study has provided evidence to show that the speech pattern during reading aloud is more syllable-timed than conversation in Cantonese PWS. Despite the rhythmic difference across discourse types, no significant difference was found in the stuttering frequency between reading and conversation in Cantonese PWS. The lack of systematic difference might be associated with the unpredictable effects of factors other than speech rhythm on the stuttering frequency in reading and conversation.

## Acknowledgements

I would like to express my deep gratitude to my supervisor, Dr. Carol To and co-supervisor, Mr. Thomas Law from the Chinese University of Hong Kong, for their guidance and support and being the inter-raters of the study. I would also like to thank all the participants for their participation in the study.

**References**

Andrews, C., O'Brian, S., Harrison, E., Onslow, M., Packman, A., & Menzies, R. (2012). Syllable-Timed Speech Treatment for School-Age Children Who Stutter: A Phase I Trial. *Language, Speech and Hearing Services in Schools, 43*(3), 359-369.

Bauer, R. S. (1997). *Modern Cantonese phonology*. Berlin; New York: Mouton de Gruyter.

Boersma, P., & Weenink, D. (2011). Praat: doing phonetics by computer [Computer program] (Version 5.2.10). Retrieved from http://www.praat.org/

Dellwo, V. (2006). Rhythm and speech rate: A variation coefficient for deltaC. In P. Karnowski & I. Szigeti (Eds.), *Language and language-processing* (pp. 231-241). Frankfurt am Main: Peter Lang.

Dellwo, V., & Wagner, P. (2003). Relations between language rhythm and speech rate *Proceedings of the 15th international congress of phonetics sciences* (pp. 471-474). Barcelona.

Grabe, E., & Low, E. L. (2002). Durational variability in speech and the rhythmic class hypothesis. In C. Gussenhoven & N. Warner (Eds.), *Laboratory Phonology VII* (pp. 515-546). Berlin ; New York: Mouton de Gruyter.

Greiner, J. R., Fitzgerald, H. E., & Cooke, P. A. (1986). Speech fluency and hand performance on a sequential tapping task in left- and right-handed stutterers and nonstutterers. *Journal of Fluency Disorders, 11*(1), 55-69.

Guitar, B. (2006). *Stuttering : an integrated approach to its nature and treatment* (3rd ed. ed.). Baltimore, Md.: Lippincott Williams & Wilkins.

Howell, P., Au-Yeung, J., & Sackin, S. (1999). Exchange of Stuttering From Function Words to Content Words With Age. *Journal of Speech, Language and Hearing Research, 42*(2), 345-354.

Ingham, R. J., Kilgo, M., Ingham, J. C., Moglia, R., Belknap, H., & Sanchez, T. (2001).

Evaluation of a Stuttering Treatment Based on Reduction of Short Phonation Intervals. *Journal of Speech, Language & Hearing Research, 44*(6), 1229.

Johnson, W. (1961). Measurements of oral reading and speaking rate and disfluency of adult male and female stutterers and nonstutterers. *Journal of Speech & Hearing Disorders, 26(Monograph Supplement 7)*, 1-20.

Lin, H., & Wang, Q. (2007). Mandarin rhythm: an acoustic study. *Journal of Chinese Language and Computing, 17*(3), 127-140.

Lincoln, M. A., & Onslow, M. (1997). Long-Term Outcome of Early Intervention for Stuttering. *American Journal of Speech-Language Pathology, 6*(1), 51-58.

Ludlow, C. L. (1990). Research procedures for measuring stuttering severity. In J. A. Cooper (Ed.), *Research needs in stuttering: roadblocks and future directions* (pp. 26-31). Rockville, Md.: American Speech-Language-Hearing, Association.

Manning, W. H. (2000). *Clinical decision making in fluency disorders* (2nd ed.). San Diego: Singular Thomson Learning.

Mok, P., & Dellwo, V. (2008). Comparing native and non-native speech rhythm using acoustic rhythmic measures: Cantonese, Beijing Mandarin and English. *Proceedings of the 4th Speech Prosody* (pp. 423-426). Campinas, Brazil.

O'Brian, S., Onslow, M., Cream, A., & Packman, A. (2003). The Camperdown Program: Outcomes of a New Prolonged-Speech Treatment Model. *Journal of Speech, Language & Hearing Research, 46*(4), 933-946.

O'Brian, S., Packman, A., Onslow, M., & O'Brian, N. (2004). Measurement of Stuttering in Adults: Comparison of Stuttering-Rate and Severity-Scaling Methods. *Journal of Speech, Language and Hearing Research, 47*(5), 1081-1087.

Packman, A. (2004). *Theoretical issues in stuttering* (1st ed. ed.). Hove ; New York: Taylor & Francis.

Packman, A., Code, C., & Onslow, M. (2007). On the cause of stuttering: Integrating theory with brain and behavioral research. *Journal of Neurolinguistics, 20*(5), 353-362.

Packman, A., Onslow, M., & Menzies, R. (2000). Novel speech patterns and the treatment of stuttering. *Disability & Rehabilitation, 22*(1-2), 65-79.

Packman, A., Onslow, M., Richard, F., & Doorn, J. V. (1996). Syllabic stress and variability: A model of stuttering. *Clinical Linguistics & Phonetics, 10*(3), 235-263.

Peters, H. F. M., & Starkweather, C. W. (1990). The interaction between speech motor coordination and language processes in the development of stuttering: Hypotheses and suggestions for research. *Journal of Fluency Disorders, 15*(2), 115-125.

Quesal, R. W. (2007). Data-based assessment of adolescents and adults who stutter. In E. G. Conture & R. F. Curlee (Eds.), *Stuttering and related disorders of fluency* (pp. 39-54). New York: Thieme.

Ramus, F., Nespor, M., & Mehler, J. (1999). Correlates of linguistic rhythm in the speech signal. *Cognition, 73*(3), 265-292.

Rao, K. S., & Koolagudi, S. G. (2013). *Emotion recognition using speech features*. New York: Springer.

Scherer, K. R., Johnstone, T., & Klasmeyer, G. (2003). Vocal Expression of Emotion. In R. J. Davidson, K. R. Scherer & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 433-456). Oxford: Oxford University Press.

Starkweather, C. W. (1987). *Fluency and stuttering*. Englewood Cliffs, N.J. :: Prentice-Hall.

Starkweather, C. W. (1999). The effectiveness of stuttering therapy: An issue for science? In N. B. Ratner & E. C. Healey (Eds.), *Stuttering research and practice: bridge the gap* (pp. 231-244). Manwah, NJ: Lawerence Erlbaum.

Teesson, K., Packman, A., & Onslow, M. (2003). The Lidcombe Behavioral Data Language of Stuttering. *Journal of Speech, Language, and Hearing Research, 46*(4), 1009-1015.

Trajkovski, N., Andrews, C., Onslow, M., Packman, A., O'Brian, S., & Menzies, R. (2009). Using syllable-timed speech to treat preschool children who stutter: a multiple baseline experiment. *Journal of Fluency Disorders, 34*(1), 1-10.

Wells, G. B. (1979). Effect of sentence structure on stuttering. *Journal of Fluency Disorders, 4*(2), 123-129.

White, L., & Mattys, S. L. (2007). Calibrating rhythm: First language and second language studies. *Journal of Phonetics, 35*(4), 501-522.

White, L., Wiget, L., Rauch, O., & Mattys, S. L. (2010). Segmentation cues in spontaneous and read speech. *Proceedings of the Fifth Conference on Speech Prosody* (pp. 1-4). Chicago.

Yoon, T.-J. (2008). Rhythm-csj1.praat [Software] (Version 1.1). Retrieved from http://web.uvic.ca/~tyoon/resource/

Appendix A

Adult stuttering questionnaire

香港中文大學
耳鼻咽喉－頭頸外科學系
言語治療科

澳洲悉尼大學
澳洲口吃研究中心

香港大學
言語及聽覺科學部

請填寫以下問卷，填妥後請交還研究人員，所有個人資料均會保密。

請填上答案或在適當的空格上填上✓號：

填寫日期：_____ 年 _____ 月 _____ 日

**甲部： 個人資料**

姓名：_____ 性別： ☐ 女 ☐ 男

出生日期：____ 年_____ 月_____ 日 出生地點：_____

**乙部： 健康史**

你有沒有被懷疑或診斷有以下的問題:

| | | | |
|---|---|---|---|
| 聽力障礙 | ☐ 沒有 | ☐ 有 | 何時? _____ |
| 語言發展障礙 | ☐ 沒有 | ☐ 有 | 何時? _____ |
| 中風 | ☐ 沒有 | ☐ 有 | 何時? _____ |
| 其他神經性疾病 | ☐ 沒有 | ☐ 有 | 何時? _____ |
| 咬字法發音困難 | ☐ 沒有 | ☐ 有 | 何時? _____ |
| 兔唇裂顎 | ☐ 沒有 | ☐ 有 | 何時? _____ |
| 自閉症或自閉症傾向 | ☐ 沒有 | ☐ 有 | 何時? _____ |
| 唐氏綜合症 | ☐ 沒有 | ☐ 有 | 何時? _____ |
| 學習困難 | ☐ 沒有 | ☐ 有 | 何時? _____ |
| 大腦麻痺/痙攣 | ☐ 沒有 | ☐ 有 | 何時? _____ |
| 弱能 | ☐ 沒有 | ☐ 有 | 何時? _____ |

除口吃外，你有沒有接受過言語治療, 物理治療, 職業治療或其他治療?

☐ 沒有 ☐ 有 ( ☐ 言語治療 ☐ 物理治療
☐ 職業治療 ☐ 其他: _____ )

## 丙部： 家庭成員資料

父親教育程度: _____ 母親教育程度: _____

父親職業: _____ 母親職業: _____

你有沒有孿生兄弟姊妹? ☐ 有，請列明數目: ___ 兄 ___ 弟 ___ 姊 ___ 妹
☐ 沒有

你有沒有兄弟姊妹? ☐ 有，請列明數目: ___ 兄 ___ 弟 ___ 姊 ___ 妹
(不包括你自己及孿生兄弟姊妹) ☐ 沒有

你與各家中成員所用的語言或方言 ? (可選超過一項)

| | | | | |
|---|---|---|---|---|
| 父親 | ☐ 廣東話 | ☐ 普通話 | ☐ 英語 | ☐ 其他: _____ |
| 母親 | ☐ 廣東話 | ☐ 普通話 | ☐ 英語 | ☐ 其他: _____ |
| 外/祖父母 | ☐ 廣東話 | ☐ 普通話 | ☐ 英語 | ☐ 其他: _____ |
| 兄弟姐妹 | ☐ 廣東話 | ☐ 普通話 | ☐ 英語 | ☐ 其他: _____ |
| 傭人 | ☐ 廣東話 | ☐ 普通話 | ☐ 英語 | ☐ 其他: _____ |

你的家庭成員有沒有言語障礙? ☐ 沒有
(可填多於一個，如有需要請問卷旁邊填寫) ☐ 有，成員是: _____ 及 _____
其障礙是: _____ _____

家庭總入息： _____

## 丁部：你口吃資料

你認為你有口吃嗎？ ☐ 沒有 ⇒ **問卷完， 謝謝！**
☐ 有 ⇒ **請繼續填寫以下問卷**

你從何時開始口吃？ _____ 歲 _____ 月

你口吃剛出現時，是否伴隨著慘痛或不愉快的經歷?
☐ 否 ☐ 是，請列明: _____

你剛出現口吃時，有以下那種行為? (可選多於一項)
☐ 重覆字或詞，例子：「***我我我***想食雪糕」 或 「***巴士巴士巴士***去邊度」
☐ 把字音拖長，例子：「***媽—媽***咪，我想玩」
☐ 說話時突然停頓，像說不出話來，例子：「我**(停頓) …** 想踢波」
☐ 臉部異常或連帶動作，如撅眉弄眼等
☐ 其他，請列明: _____

你剛出現口吃時的情況有多嚴重？
☐ 輕度 ☐ 中度 ☐ 嚴重

你從出現口吃至現在已經多久? _____ 年 _____ 月

你的口吃有沒有試過完全消失? ☐ 沒有
☐ 有，消失多久？ _____ 月

以下那些情況會令你的口吃增加？

☐ 緊張 ☐ 興奮
☐ 憤怒 ☐ 悲傷
☐ 開心 ☐ 尷尬
☐ 害怕 ☐ 其他：_____

在日常的情況下，你的口吃有多嚴重？請圈出正確的答案。

1 = 完全沒問題 9 = 非常嚴重

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|

在過去一星期，你最嚴重的口吃情況是？請圈出正確的答案。

1 = 完全沒問題 9 = 非常嚴重

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|

你對你目前的說話流暢程度有多滿意？

1 = 極滿意 9 = 極不滿意

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|

你有沒有接受有關口吃的治療? ☐ 沒有
☐ 有，何時？ _____

從你剛出現口吃至接受第一次治療之間的時間有多久? _____ 年 _____ 月

你共接受過多少次口吃的療程？ _____ 次

請你提供每次療程的資料：

第一次療程

療程由誰人提供：_____

療程次數：_____ 次 整個療程為期：_____ 月

治療方法：_____

治療的對口吃成效： ☐ 完成消除 ☐ 明顯減少
☐ 些微減少 ☐ 沒有改變

☐ 些微增加 ☐ 明顯增加
☐ 嚴重增加

第二次療程

療程由誰人提供：_____

療程次數：_____ 次 整個療程為期：_____ 月

治療方法：_____

治療的對口吃成效：
☐ 完成消除 ☐ 明顯減少
☐ 些微減少 ☐ 沒有改變
☐ 些微增加 ☐ 明顯增加
☐ 嚴重增加

第三次療程

療程由誰人提供：_____

療程次數：_____ 次 整個療程為期：_____ 月

治療方法：_____

治療的對口吃成效：
☐ 完成消除 ☐ 明顯減少
☐ 些微減少 ☐ 沒有改變
☐ 些微增加 ☐ 明顯增加
☐ 嚴重增加

**如共接受多於三次療程，請與研究人員聯絡。*

**~ 問卷完， 謝謝！~**

Appendix B

Material for the reading task

## 文房四寶

中國的文房四寶，一般是指寫字或繪畫用的筆、墨、紙、硯。它們是文人雅士的最佳伴侶。中國的書法、繪畫等藝術能享譽國際，都是它們所賜。

這裏所說的筆，是指毛筆。根據中國古書記載，筆是秦朝的蒙恬發明的。其實筆的出現時間很早，從出土的新石器時代彩陶上的圖畫來看，當時已用毛筆作畫。在商代的甲骨文中，也發現用毛筆沾墨寫成的文字。在長江出土的戰國時代帛畫中，畫了幾支毛筆，和現在的毛筆很相似。這些事例都說明在秦朝以前，中國已經有毛筆了。

毛筆的種類很多，有紫毫筆、狼毫筆、羊毫筆等，但以紫毫筆最好。有的紫毫筆價錢非常昂貴。

墨是寫字、繪畫的顏料，用煤煙或松煙製成黑色條狀。用時先把水放在硯台裏，用墨條將水研成墨汁。

據說墨是西周時代邢夷所造，距今已有二千八百多年的歷史了。實際上，在新出土的新石器時代陶器上就有墨色條紋，可見當時就已經有墨了。在商代的甲骨文中，也發現用毛筆沾墨寫成的文字，經化驗證明，當時的墨和現在墨，成份相似。戰國時代的漆器和帛畫中都有墨色，說明當時已用墨了。

墨以徽墨最好。唐代著名製墨專家奚超從北方遷徙到安徽的徽州居住，從此徽州出產的墨便稱為徽墨。徽墨是用松煙和油煙製造的。

高級的徽墨有光的優點，還放進香料，所以有清香。有些還有名家的詩畫，或雕刻各種圖案來襯托，成為具有中國風格的工藝精品。

中國是世界上最早發明造紙技術的國家，早在西漢時期，就出現了用絲棉製作的紙。經過不斷地改進，紙的種類林林總總，其中用來寫字作畫的宣紙，是中國出類拔萃的特種手工藝品之一，至今已有一千多年的歷史。

宣紙產在安徽省的宣城，所以稱為宣紙。它的特點是潔白、細密、柔軟、拉力大，存放時間很久而不變色，也不會被蟲蛀或腐蝕，並且耐久，所以有「壽紙千年」的稱譽。宣紙的另一個特點是厚薄均勻，吸水力強，墨汁一落在紙面上就很快滲透，所以用宣紙寫字作畫最好。

硯在中國已有三千多年的歷史。早在春秋戰國時代就出現了石硯。魏晉時代硯的種類更多了，如瓷硯、銅硯、銀硯等。到了唐代，陶硯比較流行，並且製造出著名的端硯。

端硯是用端石製作的。端石出產在廣東省肇慶東郊的端溪，所以人們把這裏製作的硯稱為端硯。端硯最大的特點是質地細密，溫潤硬滑，便於研墨存墨，並且出墨快。研磨出的墨汁細膩，有光澤，夏天不容易乾掉，冬天也不容易凍結，沾筆圓潤，便於書寫。名貴的端硯不但硯石好，而且還雕琢各種精美的山水、風景、人物等圖案，是高級的工藝珍品。

文房四寶在傳播中國文化，發展中國的書法、繪畫藝術等方面，作出了卓越的貢獻。